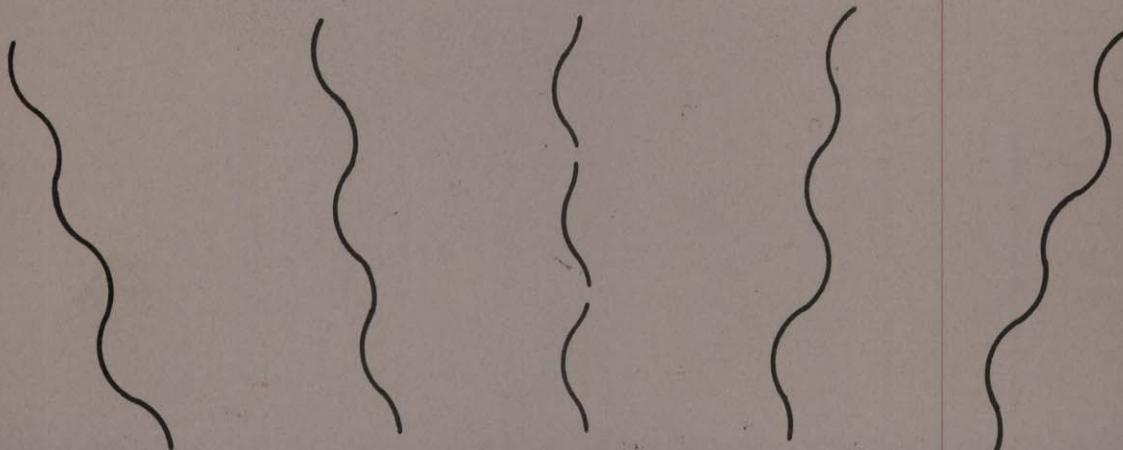


A 57.2: Ev 1/2

# EVAPORATION



DESIGN FOR POND AGRICULTURAL WASTEWATER DISPOSAL

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SOIL CONSERVATION SERVICE  
U.S. DEPARTMENT OF AGRICULTURE

FEBRUARY 1974

TECHNICAL NOTE: ENVIRONMENT NO.7

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# TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

ENVIRONMENT No. 7

Bozeman, Montana  
February 15, 1974

RE: Agricultural Waste Management---Evaporation Pond Design

Disposal of polluted runoff by use of an evaporation pond is a successful method if the proper climatic and site conditions exist. This technical note will describe these desirable conditions and provide a basis for pond design.

### Site Suitability

Effective functioning of the pond will require a mean annual evaporation of at least 10 inches per year greater than the average annual precipitation. The proposed site should be relatively flat to minimize earth-work costs. The soil should be of a very low permeability or one that may be made impervious. The seasonal high water table should be at least two feet below the proposed bottom of the sealed pond. The pond will produce odors. The site should be isolated to allow dissipation of odors before they reach the general public.

### Design Considerations and Recommendations

A settling basin to remove eroded manure solids is recommended for feedlots with slopes exceeding 2 percent.

If a large pond is required and the land is suitable for crops or grazing, the pond may be divided into cells. This would allow use of portions of the pond during years of low runoff. Weir structures would provide water control from cell to cell.

Attempt to use marginal farmland such as saline or canal seep damaged areas. Pond locations in glacial till or in shallow soils underlain by shale should be investigated to prevent the aggregation or origination of a saline seep.

Consider the use of a salt-tolerant and emergent tolerant grass to reduce dust during dry periods. Western wheatgrass or reed canarygrass are suggested.

It is important to check infiltration rates at pond sites to determine if compaction or other sealing methods are needed.

Design Notes

The use of a 1.0 runoff coefficient was requested by state health authorities. This provides a safety factor for variables such as antecedent moisture, intensity of precipitation, depression (hoofprint) storage, frozen urine, etc.

The following design procedure determines the area of pond required to evaporate dry during a year of above normal precipitation and of below normal evaporation. Above normal precipitation was approximated from precipitation records as 1.3 times the average precipitation. Below normal evaporation was accommodated by using the mean shallow lake evaporation which is less than the evaporation of a shallow basin. The pond depth is determined by the storage required to hold winter and spring runoff for the higher summer evaporation period.

Design Procedure

1. From Appendix A determine the mean annual shallow lake evaporation, E.
2. From Appendix B determine the average annual total precipitation, P.
3. Check for practicality of evaporation pond: Is  $E > P$  by at least 10 inches per year?
4. Evaporation Pond area required:

$$A_p = \frac{1.3(PA_L) + R_o}{E - 1.3P}$$

Where:

$A_p$  = Required evaporation pond area in acres.  
1.3 = Factor to obtain non-average total precipitation.  
 $P$  = Average annual total precipitation in inches (Appendix B).  
 $A_L$  = Lot area in acres.  
 $E$  = Mean annual shallow lake evaporation in inches (Appendix A).  
 $R_o$  = Annual runoff from surfaces other than feedlot pens and feed storage areas in acre-inches.

Note: This is external runoff that is not diverted from entering the feedlot and may be computed as annual yield using the Engineering Field Manual.

5. Evaporation pond depth required:

$$D = \frac{P_w(PA_p) + P_w(PA_L) + P_w(R_o)}{A_p}$$

Where:

$D$  = Required evaporation pond depth in inches.  
 $P_w$  = Winter precipitation factor (Appendix C).  
Others as above.

6. Increase design depth to next half foot or to desired freeboard.

APPENDIX A

Mean Annual Evaporation-  
Shallow Lakes and Reservoirs

The following figures, 1 thru 3, were developed from evaporation data at individual weather stations. In western Montana, local experience and judgement should be used for particular locations to modify the 35" evaporation shown.

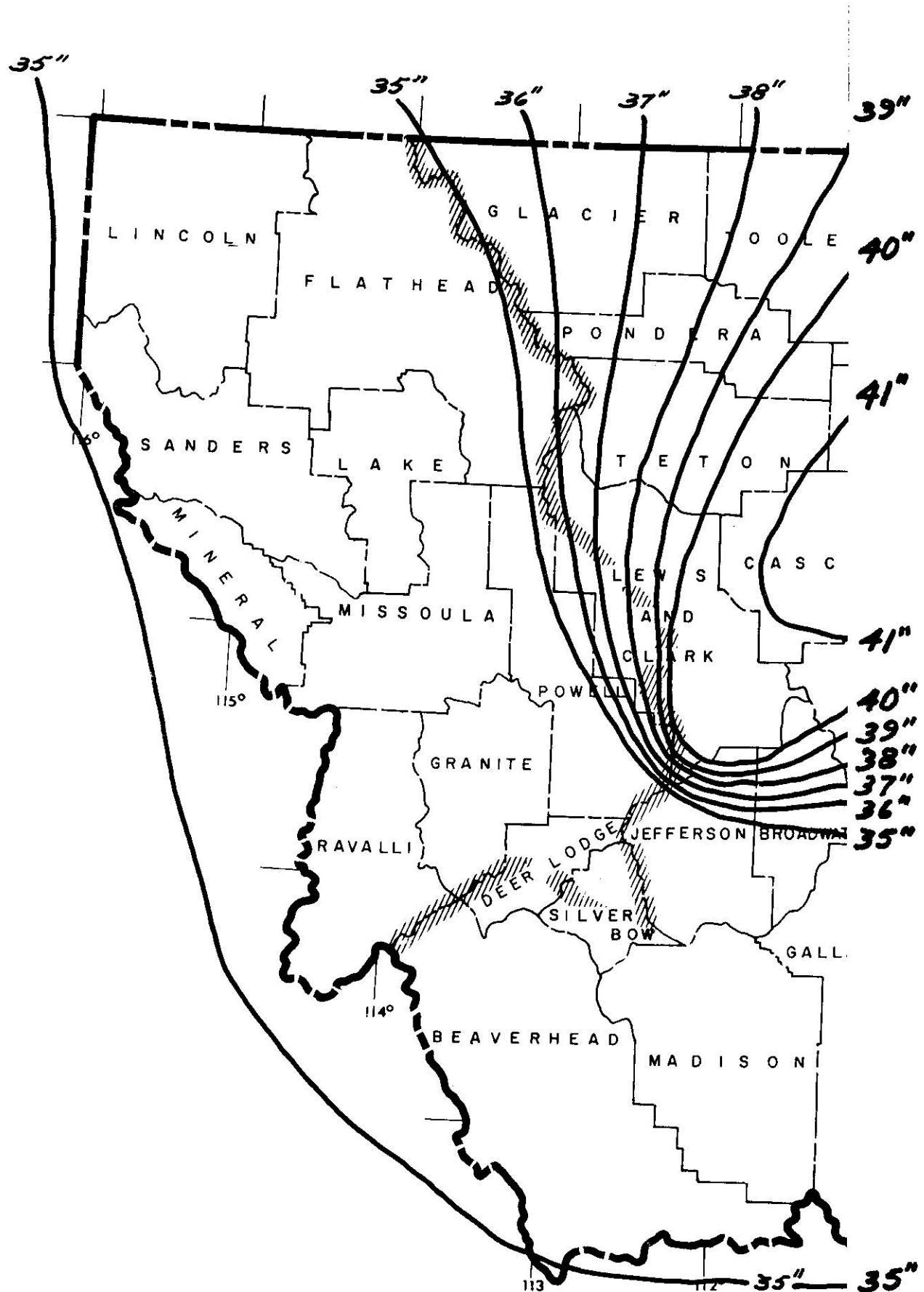
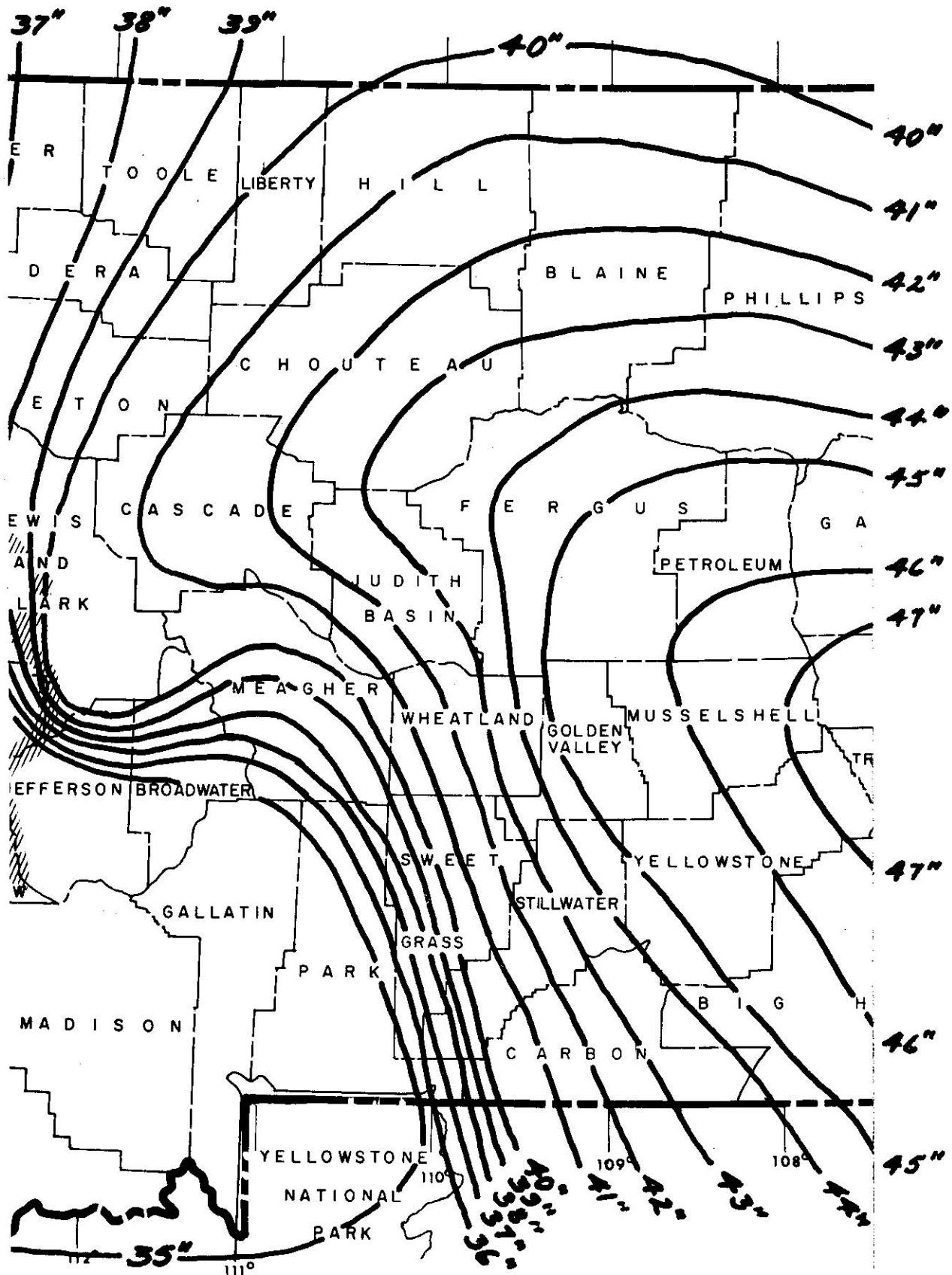


Fig. I

MEAN ANNUAL EVAPORATION  
SHALLOW LAKES AND RESERVOIRS



**Fig. 2 MEAN ANNUAL EVAPORATION  
SHALLOW LAKES AND RESERVOIRS**

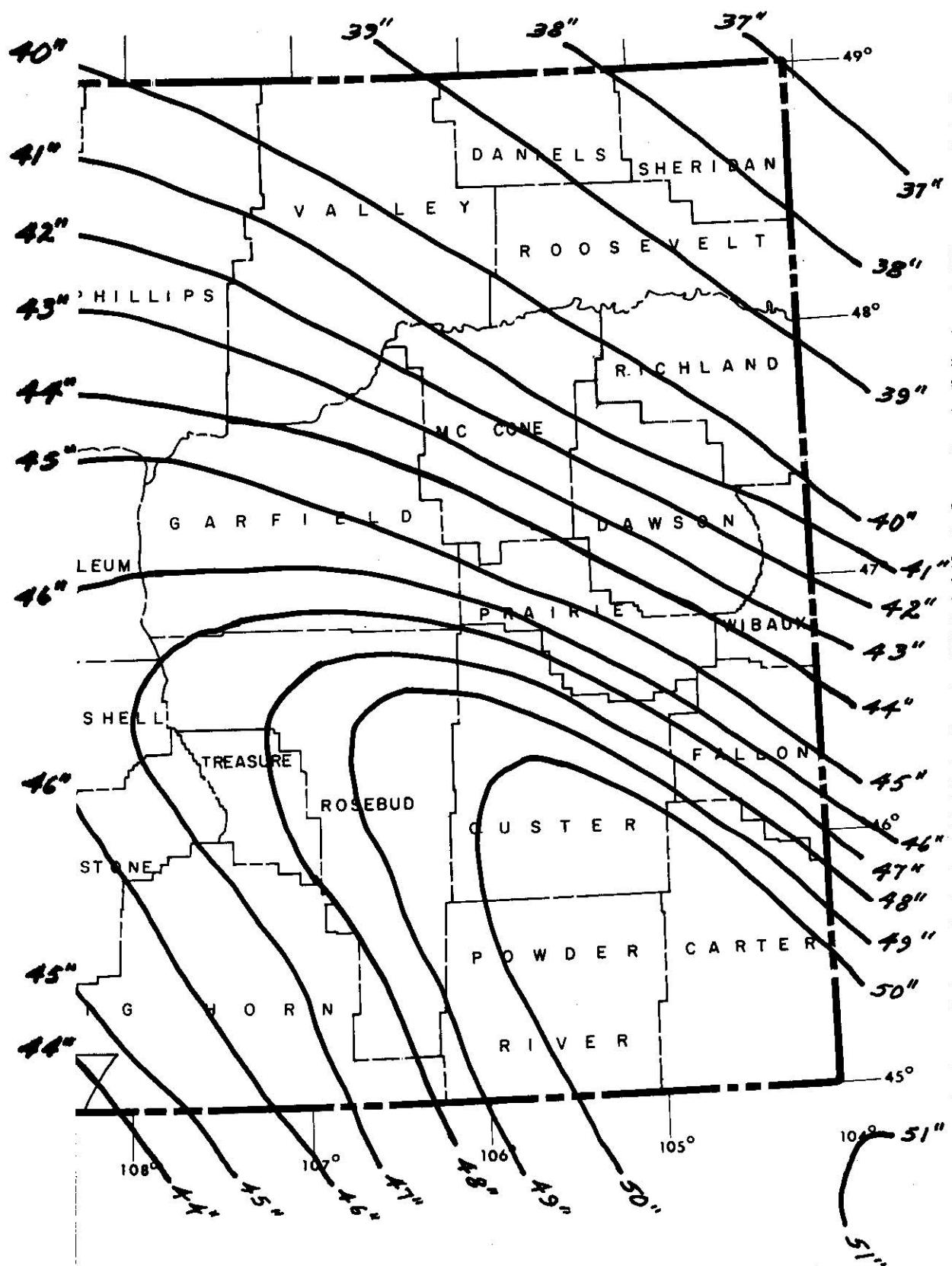


Fig. 3 MEAN ANNUAL EVAPORATION  
SHALLOW LAKES AND RESERVOIRS

APPENDIX B

Average Annual Precipitation

From Figure 4, locate the precipitation sheet for your location. The sheets show total precipitation.

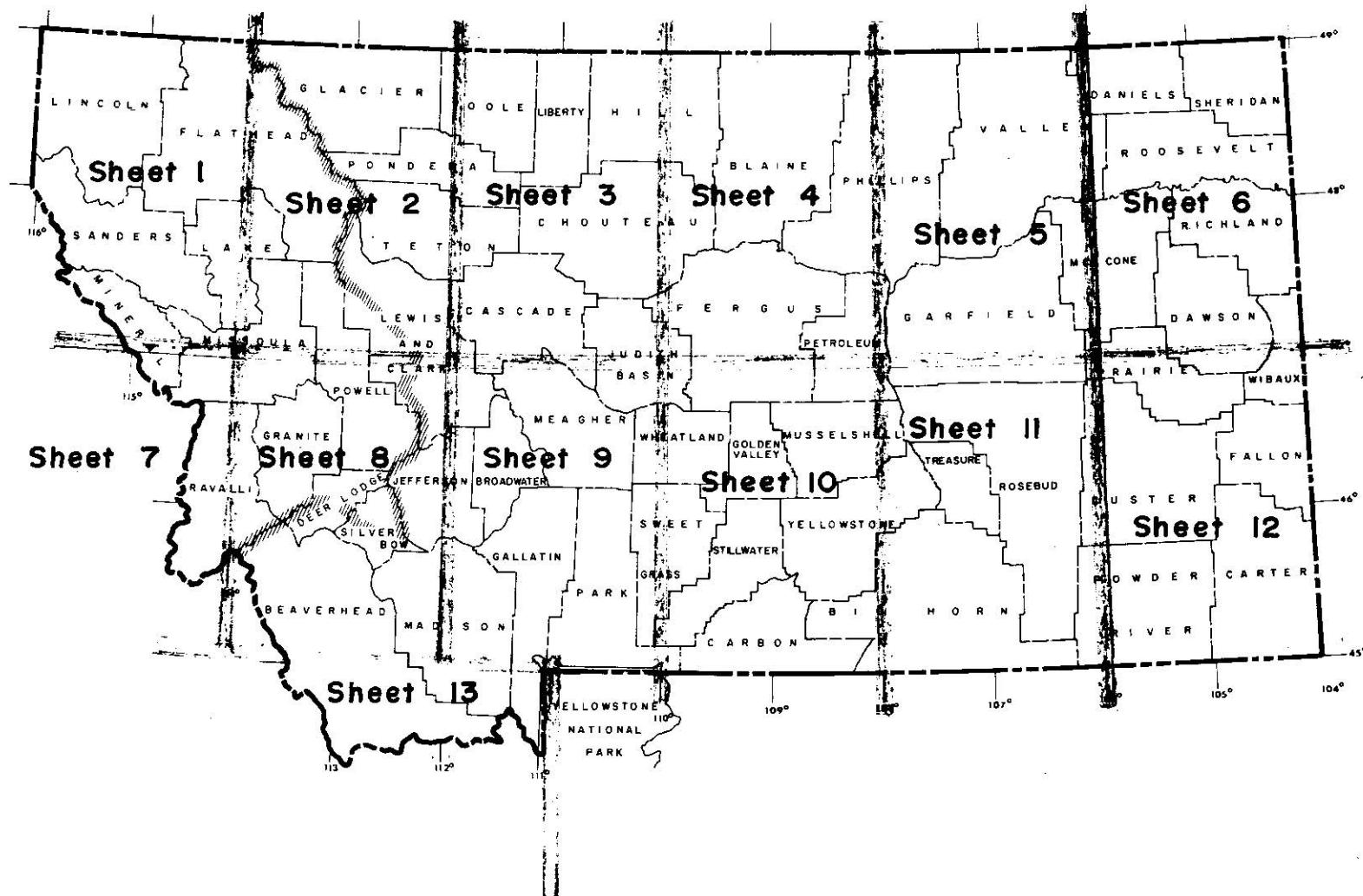
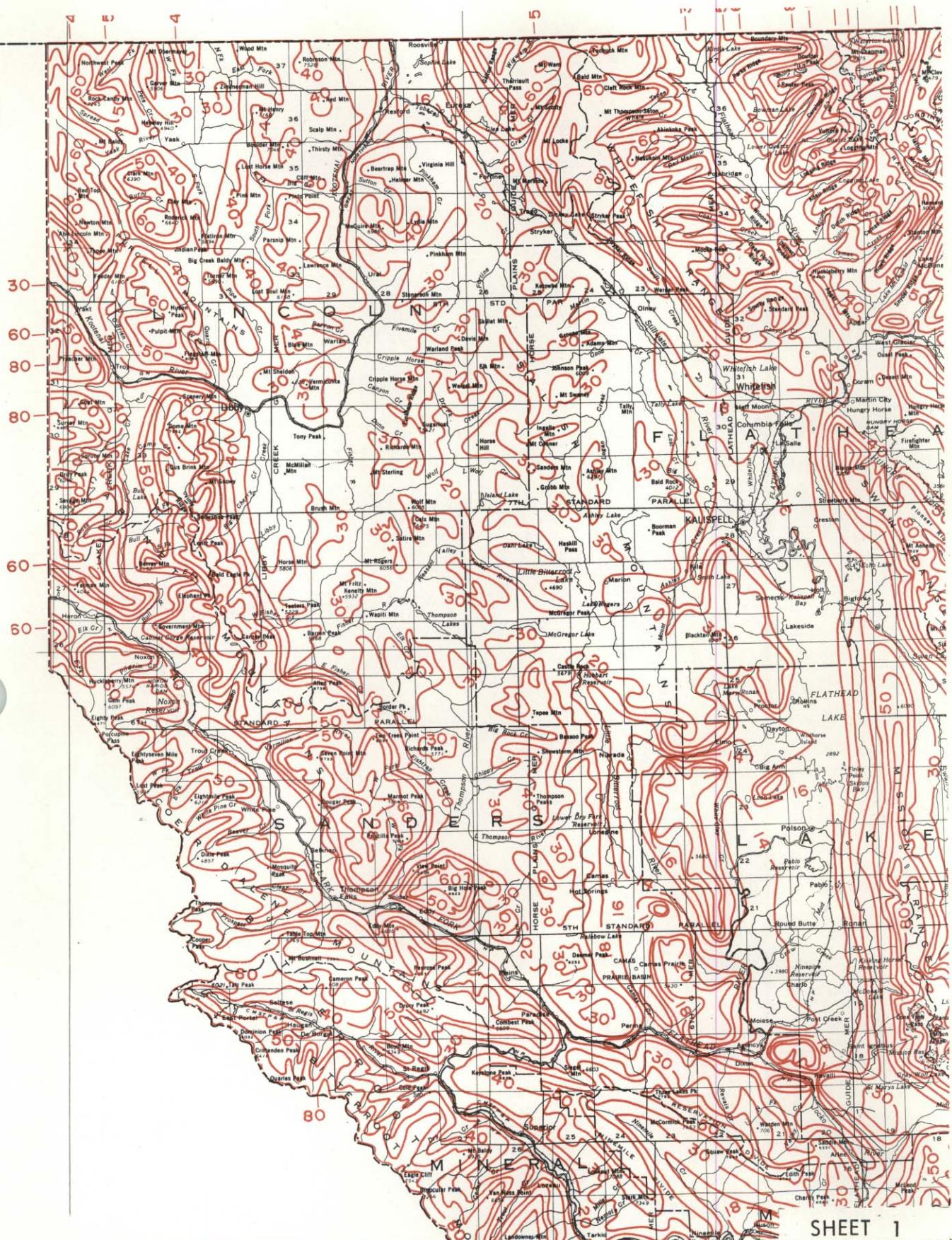


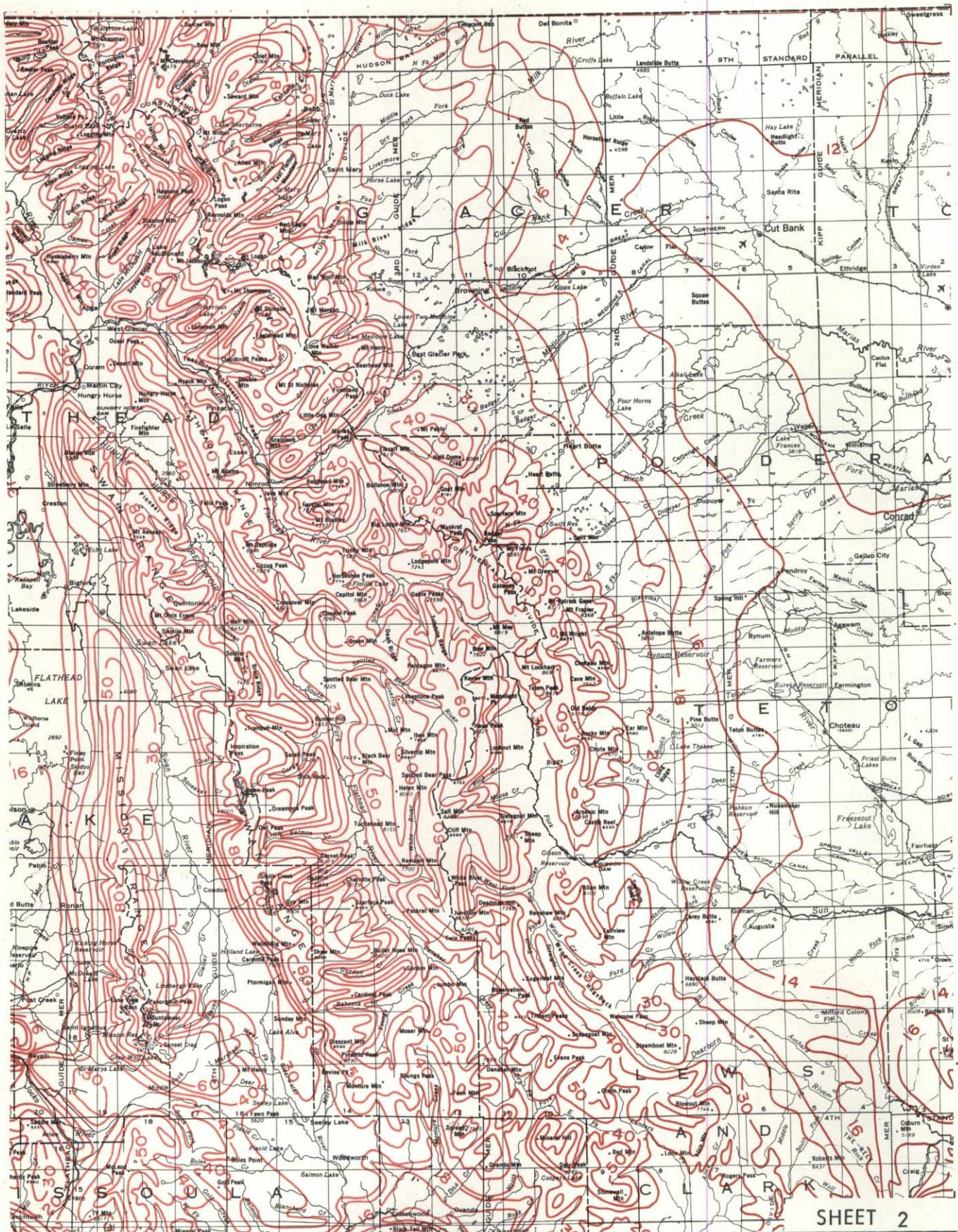
Fig. 4 DIRECTORY OF PRECIPITATION SHEETS



SHEET 1

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on 1941-70 period is prepared and re-  
leased by SCS, National Weather Service  
and Montana Water Resources Board.  
Prepared by: SCS, Box 970, Bozeman, MT.

Scale: 1 inch equals approx. 16 miles  
STATE OF MONTANA  
AVERAGE ANNUAL PRECIPITATION  
IN INCHES  
Soil Conservation Service 1953-67 Base

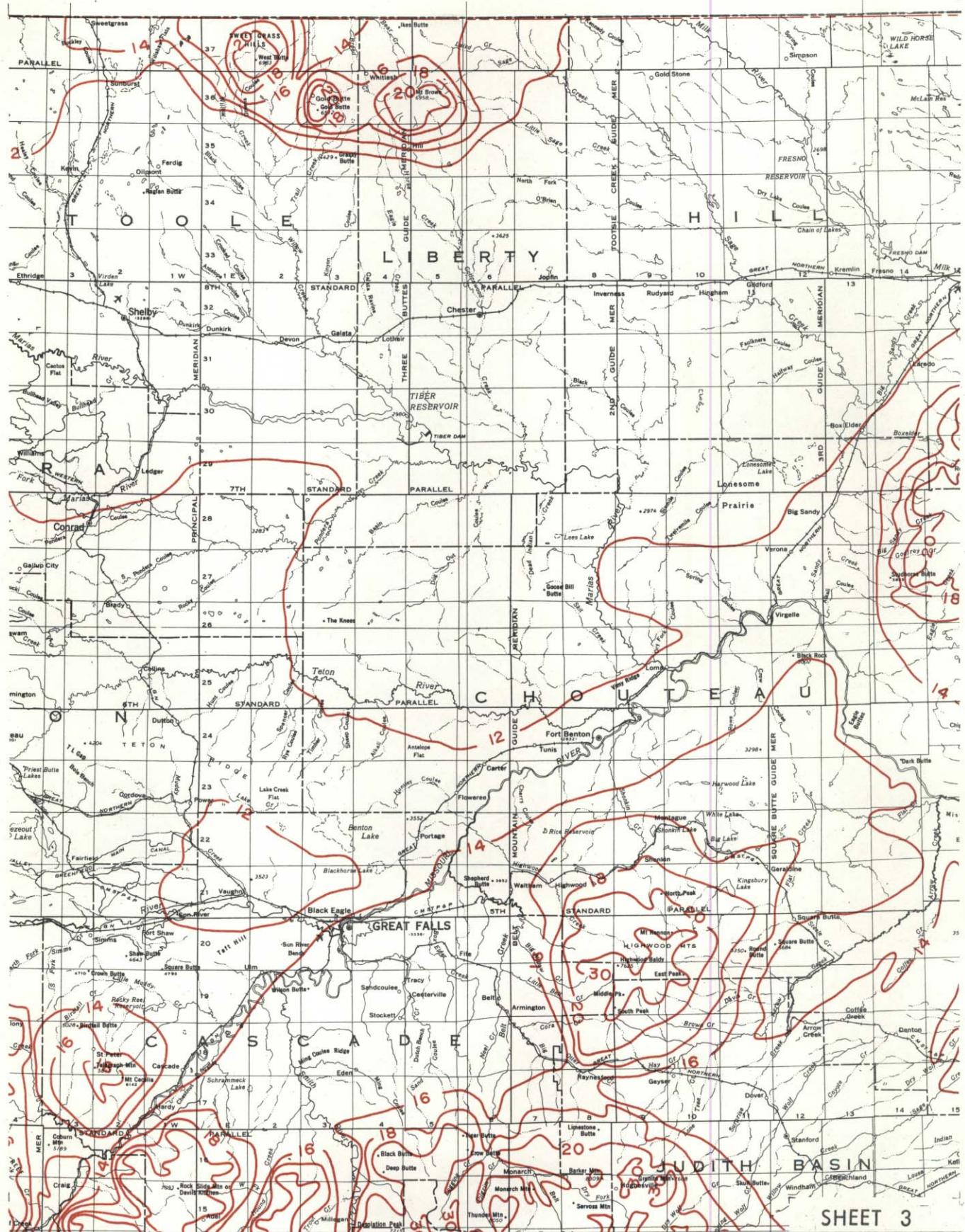


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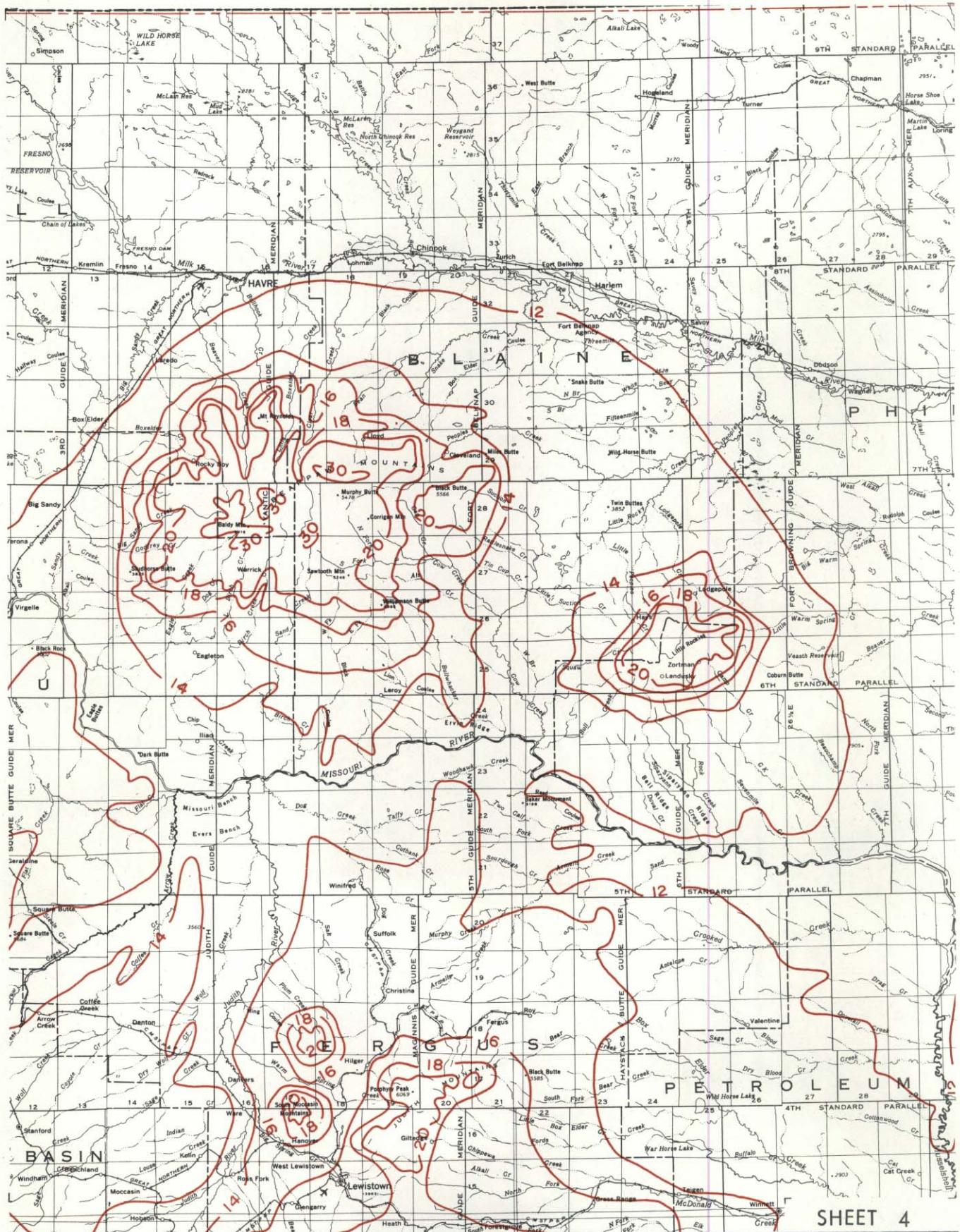
Prepared by: SCS, Box 970, Bozeman, MT.

Scale: 1 inch equals approx. 16 miles  
**STATE OF MONTANA**  
**AVERAGE ANNUAL PRECIPITATION**  
**IN INCHES**  
 Soil Conservation Service 1953-67 Base



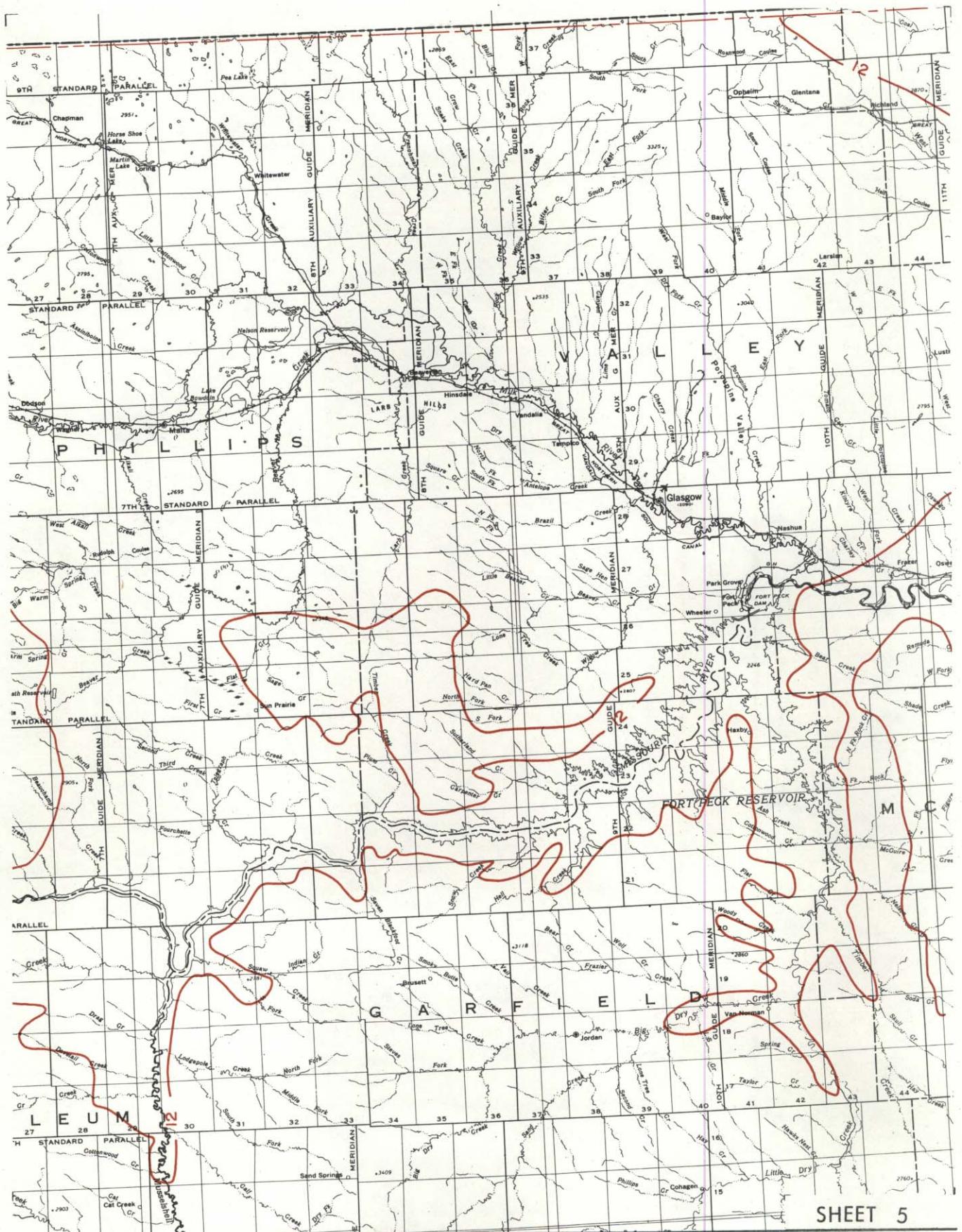
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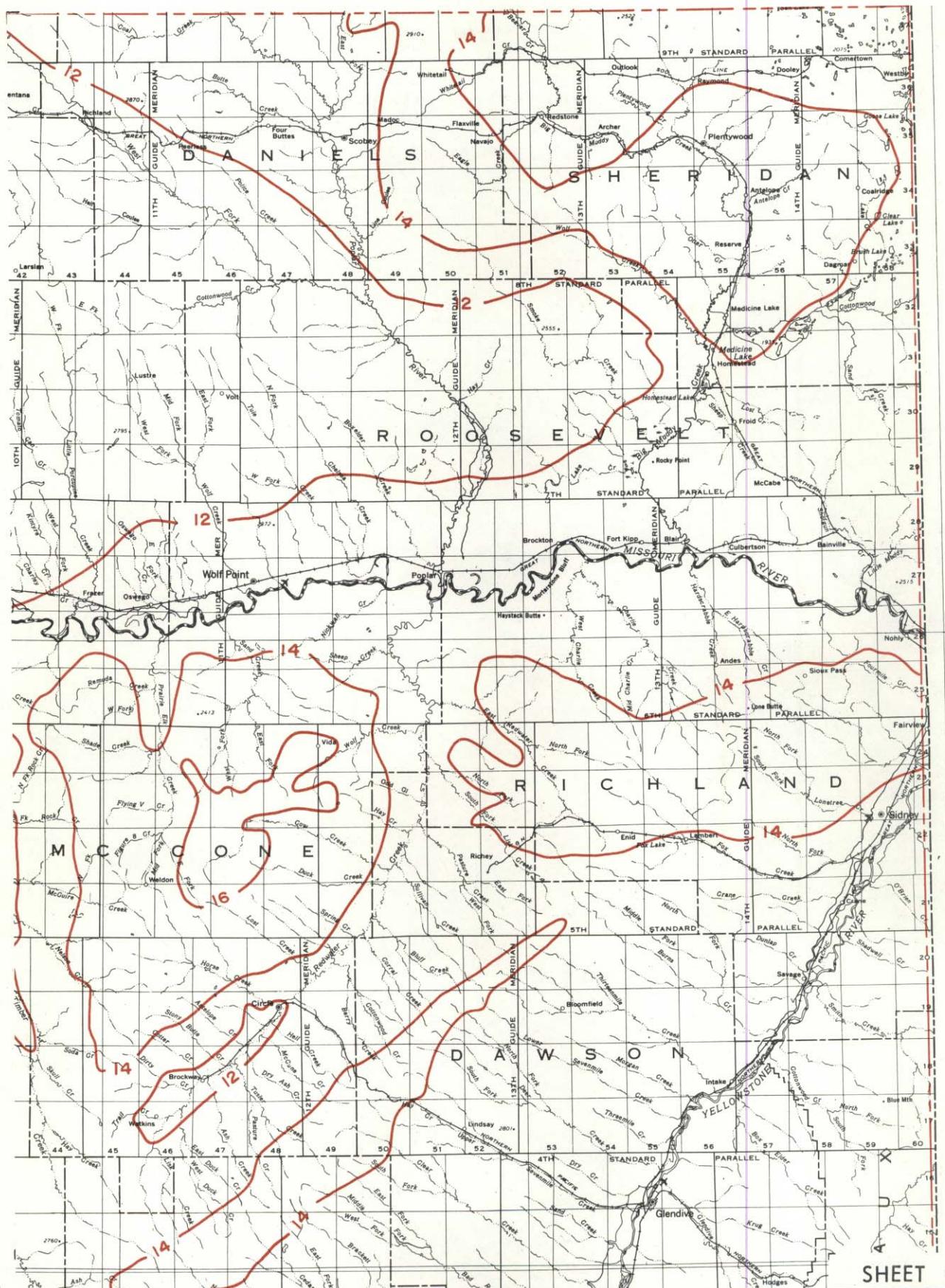
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SHEET 5

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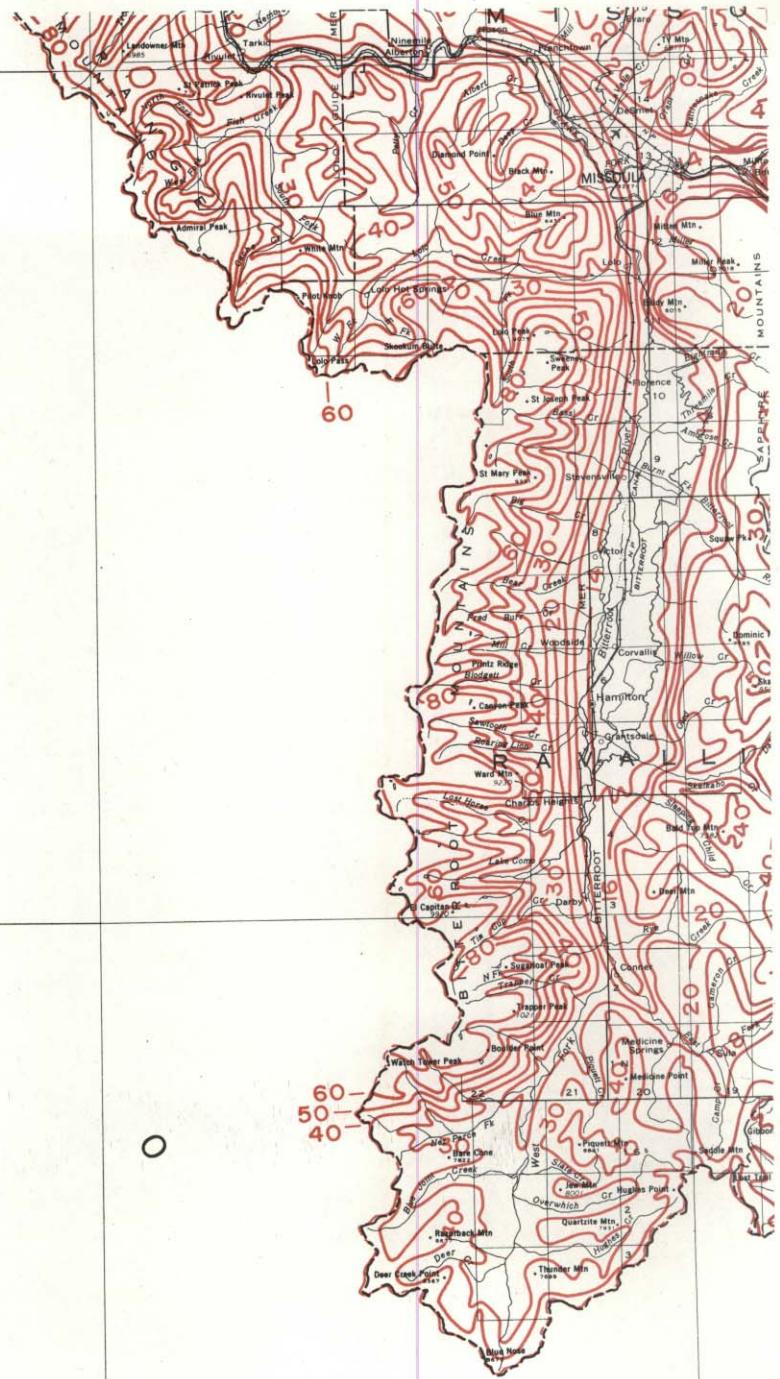
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STATE OF MONTANA  
AVERAGE ANNUAL PRECIPITATION  
IN INCHES  
Soil Conservation Service 1953-67 Base



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**IN INCHES**  
Soil Conservation Service 1953-67 Base



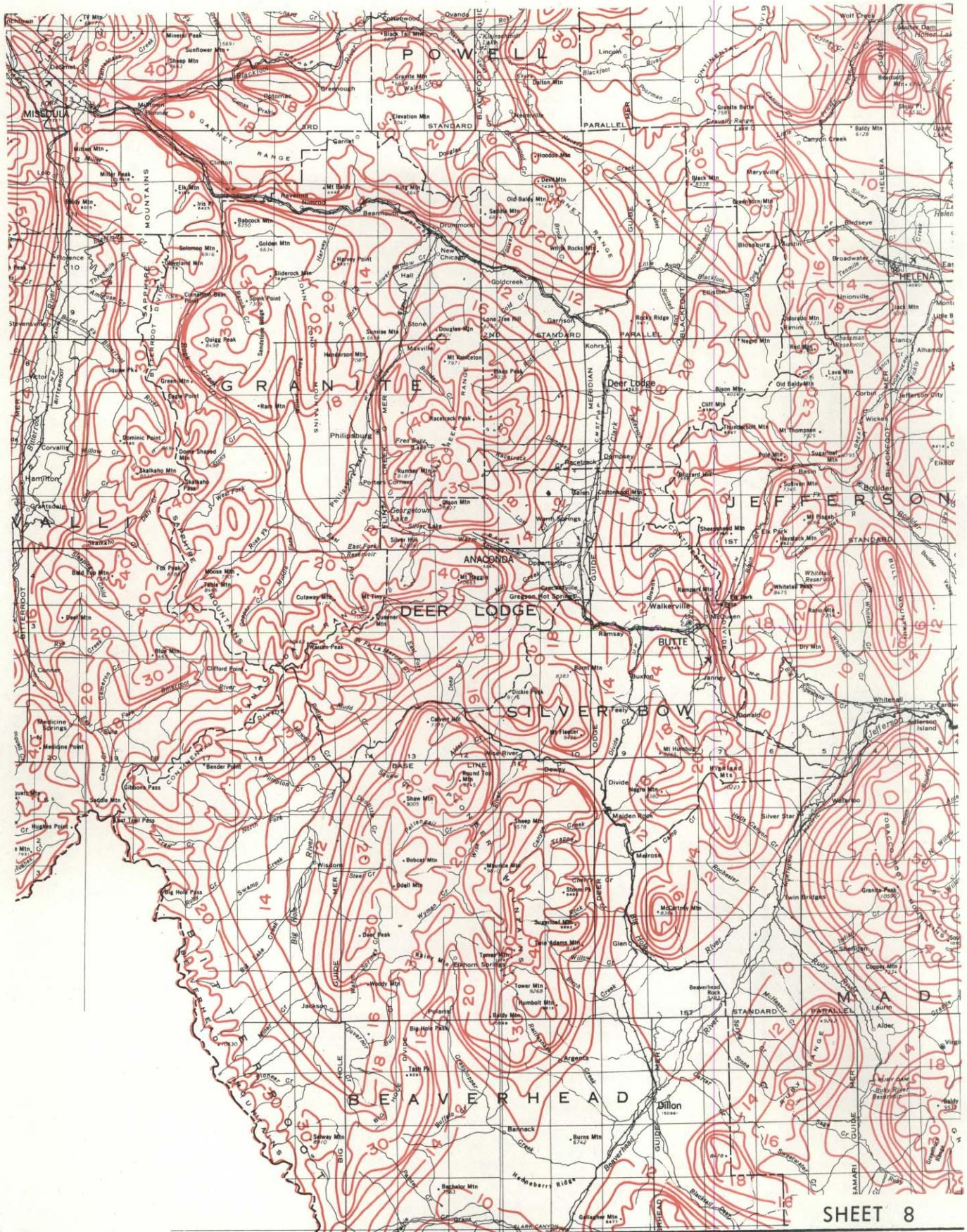
UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

## STATE OF MONTANA

SHEET 7

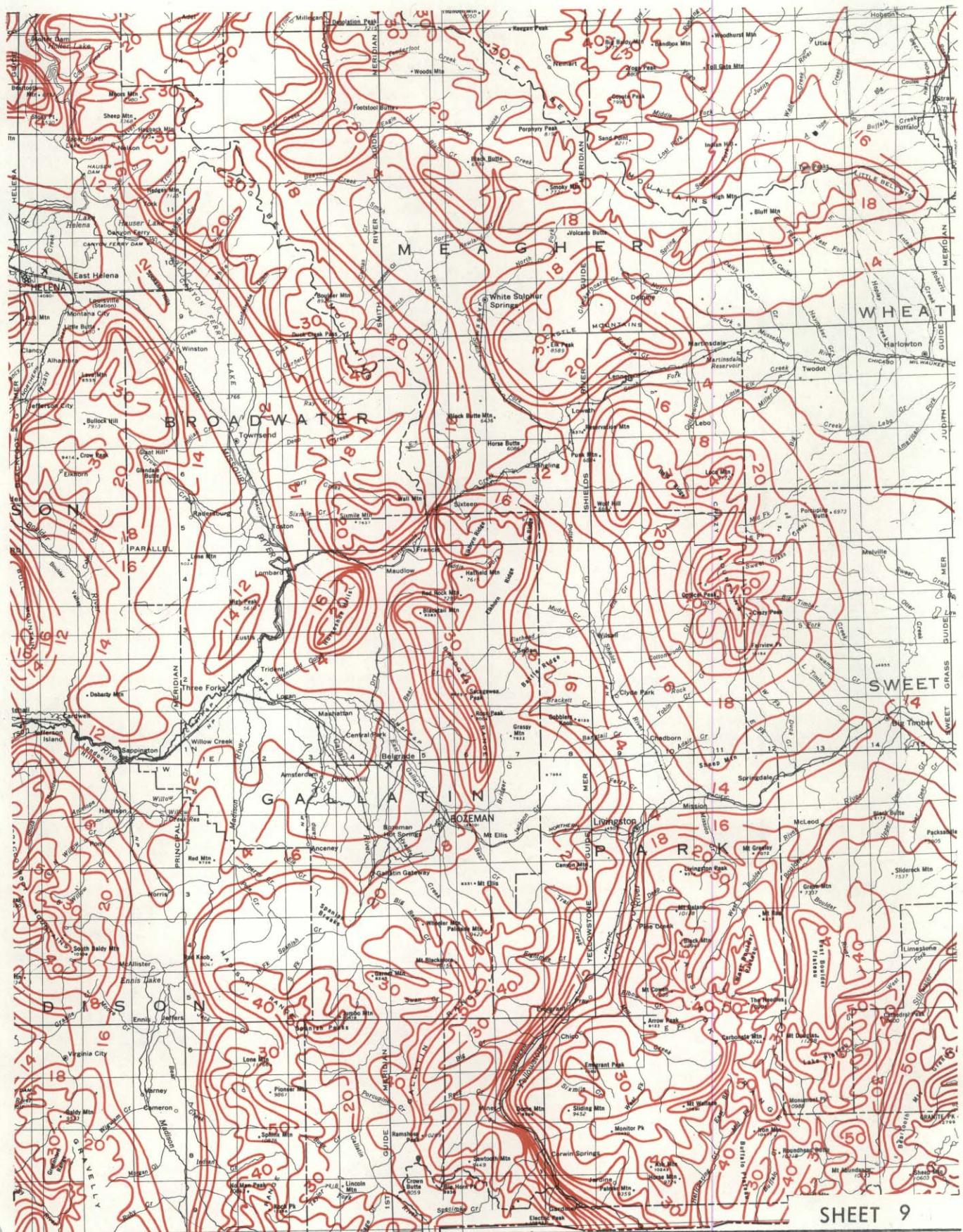
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AVERAGE ANNUAL PRECIPITATION  
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Soil Conservation Service 1953-67 Base



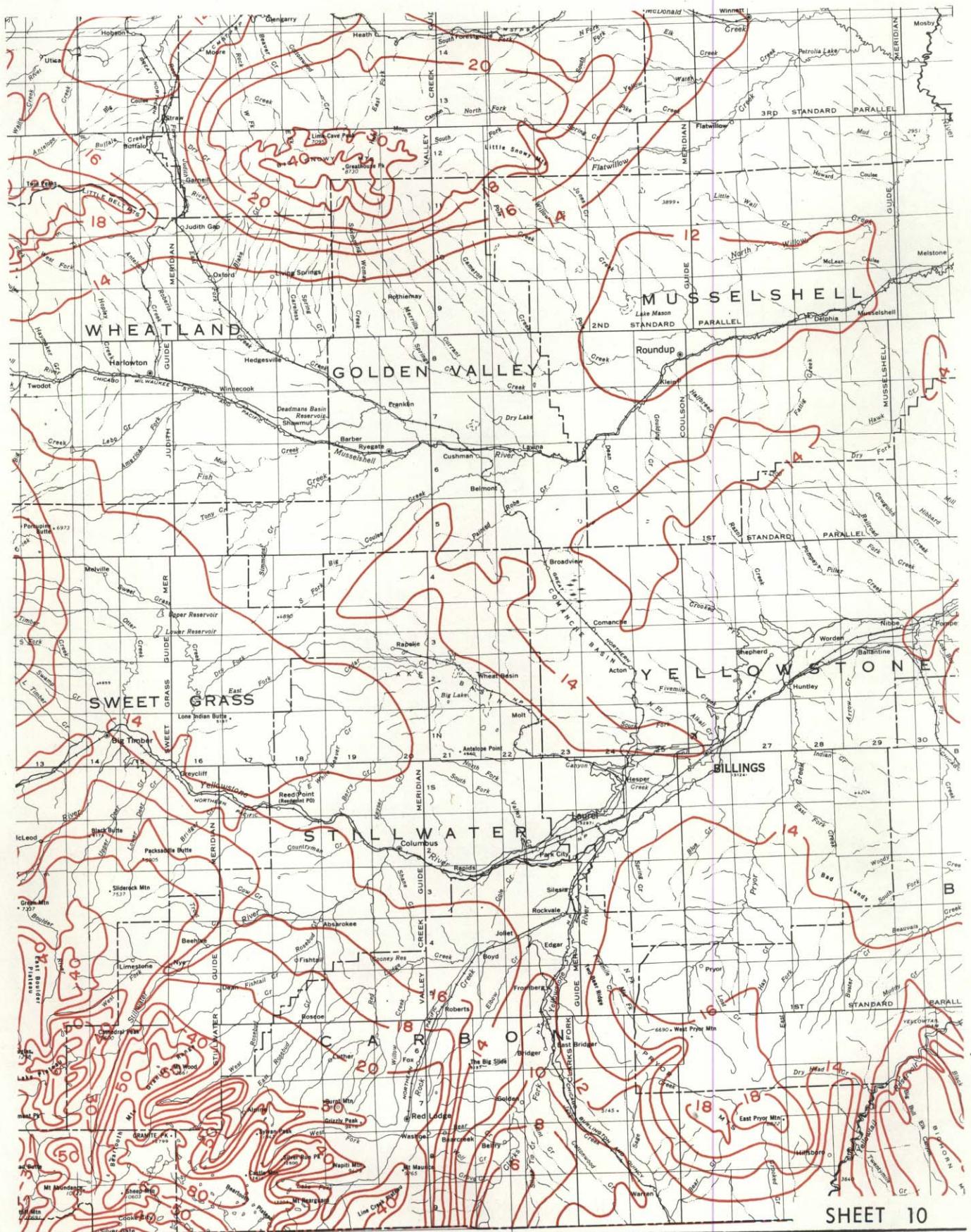
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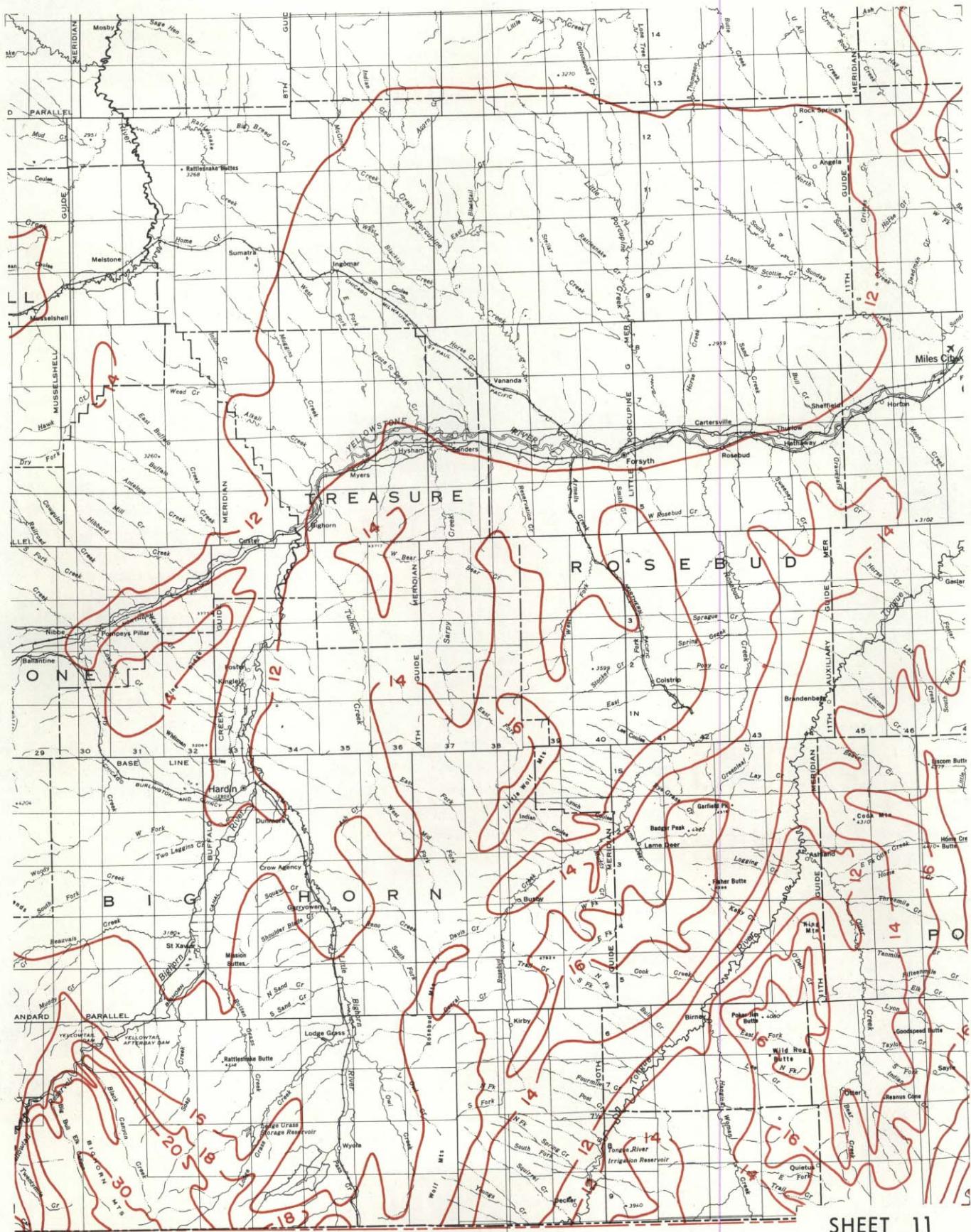
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**STATE OF MONTANA**  
**AVERAGE ANNUAL PRECIPITATION**  
**IN INCHES**  
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AVERAGE ANNUAL PRECIPITATION  
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Soil Conservation Service 1953-67 Base

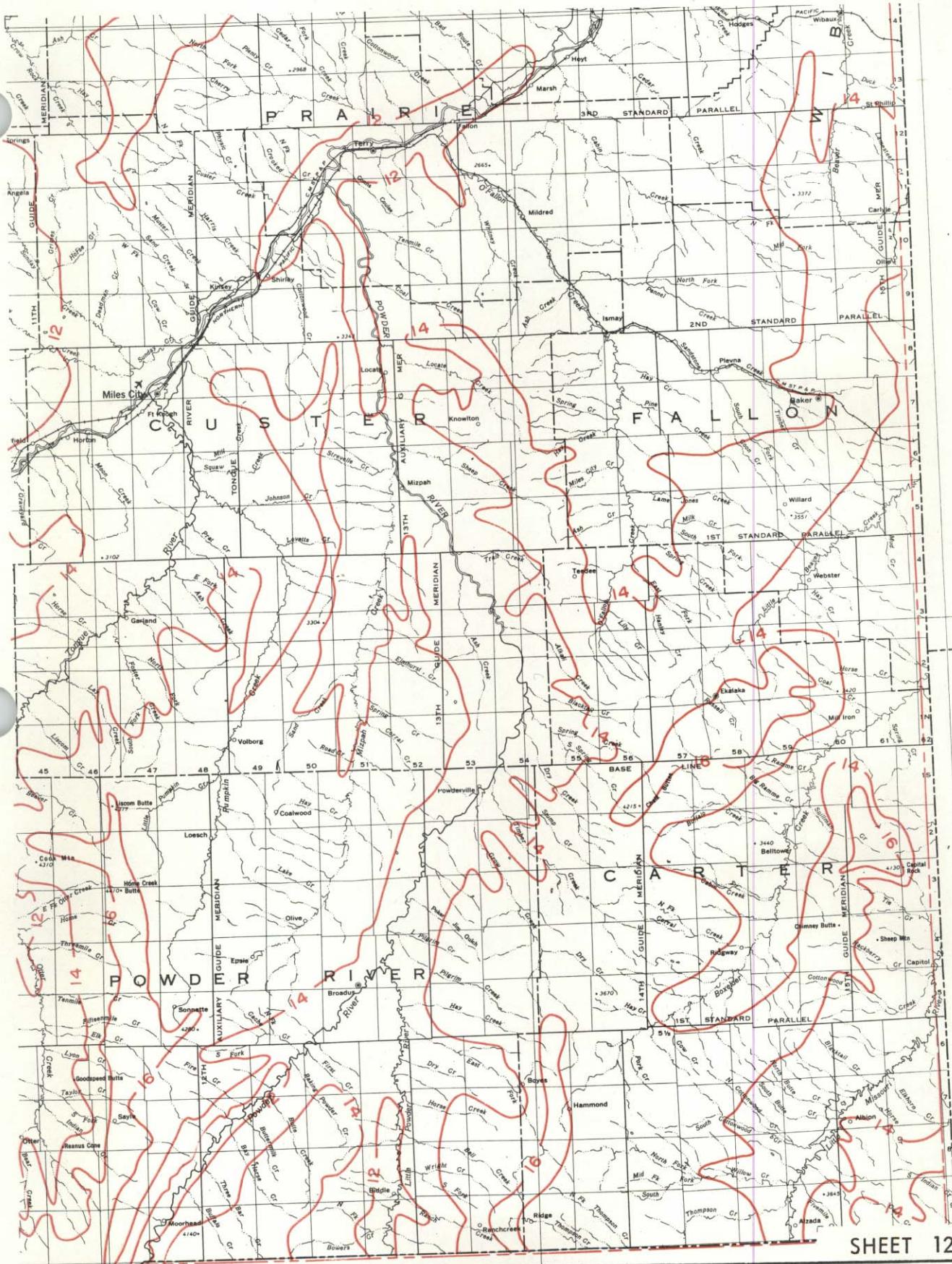


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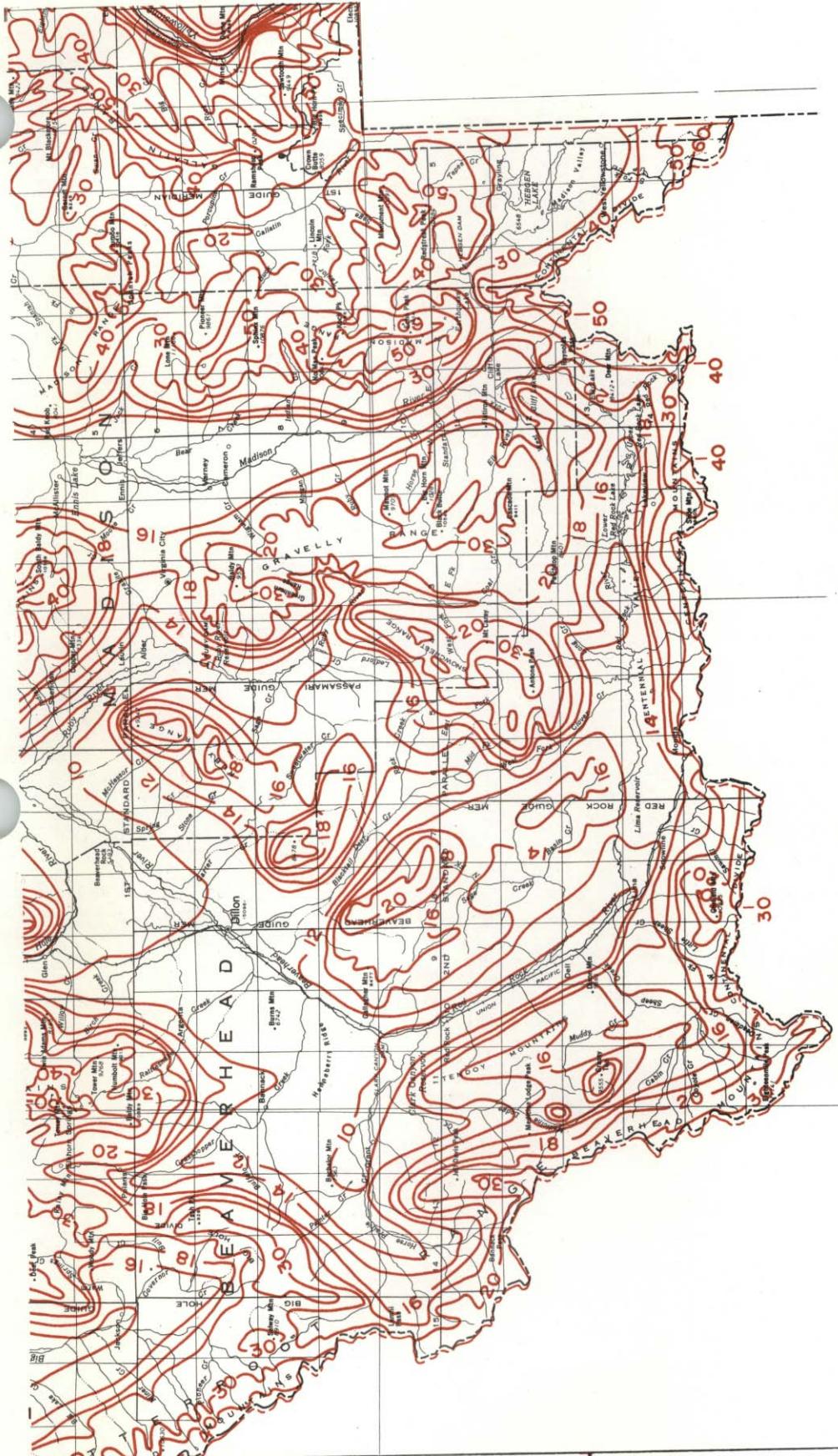
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D A K O T A N O R



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SHEET 13

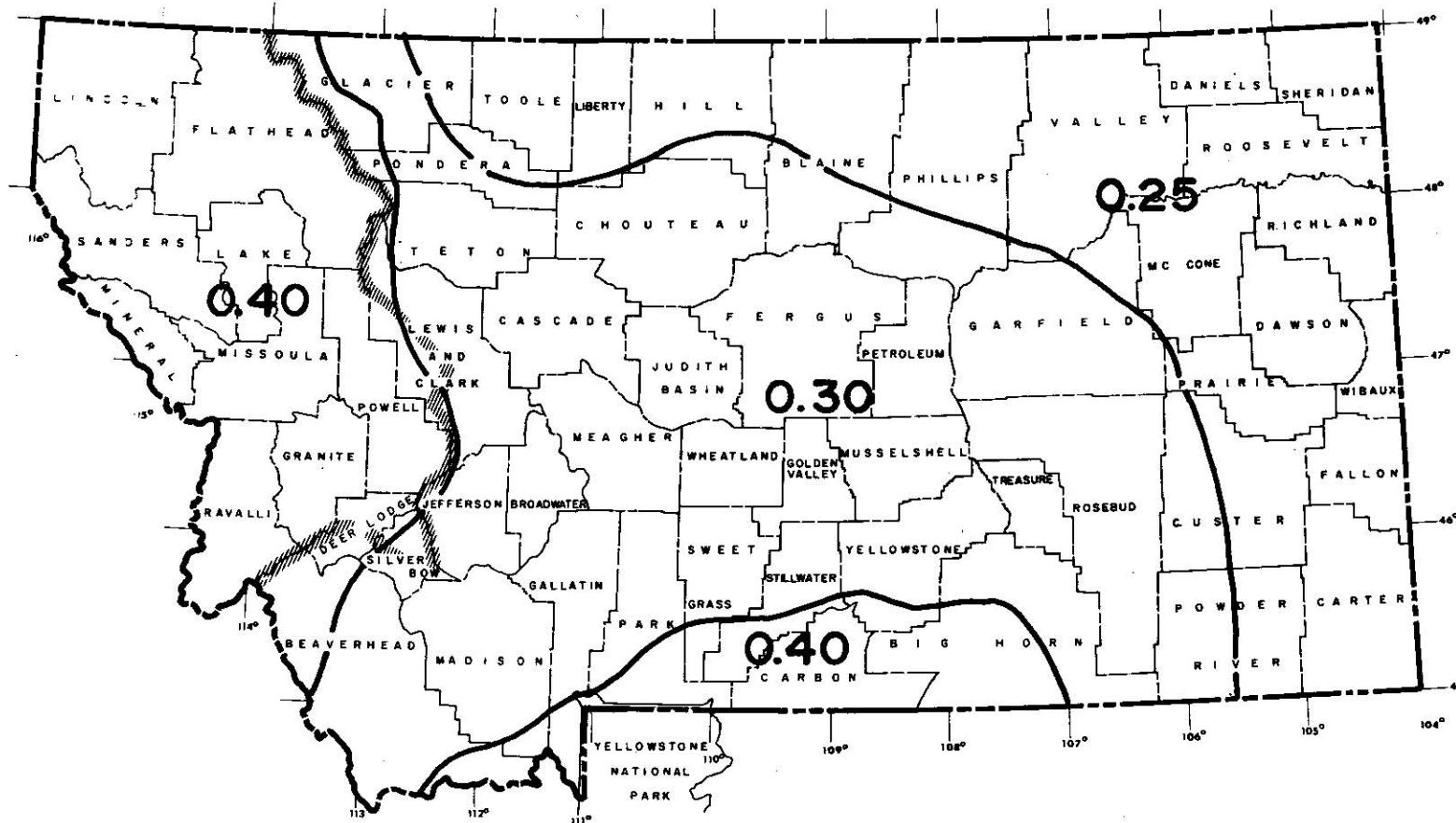
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## APPENDIX C

### Winter Precipitation

The Winter Precipitation Factor in Figure 5, approximates that fraction of the total annual precipitation that was recorded during November thru April. In each region the approximation is within  $\pm$  0.05 with a few exceptions. Local records, experience, or judgement may be used to modify the factor for your location.



$P_w$  approximates that portion of the total annual precipitation that fell during November thru April for the 1931-1960 base period.

Fig. 5  $P_w$ -WINTER PRECIPITATION FACTOR

